first, to discern these interesting markings. The largest spot seems to be drifting westwards, relatively to the zero meridian (System II.) of Mr. Crommelin's ephemerides, at the same rate as the S. temperate zone of Jupiter, viz. 16 degrees per month. On August 3 I observed the spot in transit at 8h. 56m., hence its longitude was 232°·8. If the westerly drift of the object is continued and its existence sufficiently prolonged, it will arrive at conjunction with the following end of the red spot in July, 1902, the longitude of the latter being about 46°. This value has shown little variation during the last twelve months.

The new marking deserves special notice from the fact that a conspicuous spot appeared in about the same latitude in the summer of 1889 and formed the subject of an interesting paper by Mr. A. S. Williams in the *Monthly Notices* for June, 1890. This spot, when its more rapid motion enabled it to overtake the red spot, was diverted southwards and its material flowed along the southern edge of the ellipse, afterwards drifting further west, freeing itself from the red spot, and finally appearing as a well-defined red streak or short belt. The present disturbance may indicate a recurrence of the phenomena of twelve years ago, and it is desirable that its future developments be closely watched. The chief spot will be central at about the following times:—

		h.	m.
August	10	9	35
,,	12	11	11
,,	15	8	38
,,	17	10	15
,,	20	7	42
,,	22	9	18

Bristol, August 4.

W. F. DENNING.

MEASUREMENTS OF SOLAR RADIATION.[1]

IT is impossible within the limits of a short notice to give any detailed description of Prof. S. P. Langley's great work, contained in his first volume of the "Annals of the Astrophysical Laboratory of the Smithsonian Institution." It is an account of his experiments with the bolometer, begun on Mount Whitney in 1881 and continued for eighteen years, first at the Allegheny Observatory and, since 1890, at the Smithsonian Institution at Washington. The volume before us deals with this last period; the results of the earlier period are contained in the Report of the Mount Whitney Expedition, published as one of the professional papers of the U.S. Signal Service Department and elsewhere. Striking as these were, their interest and importance is entirely eclipsed by the new work.

Those who were fortunate enough to be at the Oxford meeting of the British Association in 1894 heard from Prof. Langley himself an account of his researches up to that date. The details on which that account was based are given in the new volume, together with the results of a completely new set of measurements, made in 1897-98.

Probably only the few who have used the bolometer can fully appreciate its difficulties. The principle of the research is simple. A spectrum is formed by suitable means and allowed to fall on the bolometer, a very narrow strip of blackened platinum placed parallel to the lines of the spectrum; this strip forms one of the arms of a Wheatstone's bridge, the other arms being a similar strip and two equal bridge coils. A screen is interposed between the spectrum and the bolometer, and the bridge adjusted until the galvanometer is undeflected. On removing the screen the bolometer strip is heated by that part of the spectrum which falls on it; its resistance is changed and, assuming the battery current to remain constant, the deflection of the galvanometer spot is a measure of the change of resistance of the strip and hence of the energy which it absorbs from the spectrum.

The spectrum is then made to pass slowly across the strip; by noting the corresponding deflections of the galvanometer, a map can be drawn showing the distribution of energy in the spectrum. In a region of a great energy the deflection is large, but as an absorption band crosses the strip it falls towards zero. When it is stated that a variation in the temperature of the strip of less than one millionth of a degree affects the galvanometer appreciably, some of the difficulties become apparent; the very slightest changes in temperature of any part of the electrical system produce effects in the galvanometer which mask the effects it is sought to observe.

In early days the observations were made by eye. The circle carrying the prism or grating which formed the spectrum was set and its position noted; then the screen was removed and the galvanometer deflection read. The circle was then moved and the operations repeated. In 1891-92 the apparatus was made autographic; the circle was turned uniformly by means of a clock, thus the spectrum crossed the bolometer strip at a uniform rate, while the spot of light from the bolometer mirror was focussed on to a sheet of photographic paper, which was made to move vertically at a rate bearing a fixed ratio to that of the circle. On developing the sheet a bolograph was formed, a curve in which the coordinate of any point measured parallel to the direction of motion of the sheet determines the portions of the spectrum to which the point corresponds, while the coordinate measured at right angles to the direction of motion gives the energy received by the strip from that portion of the spectrum. Peaks on the curve correspond to maxima of radiation, depressions to absorption bands or minima of radiation.

A very large number of these bolographs were taken, and the work contains numerous examples. The same general features recur in them, though of course there are small variations from day to day, some of which are real, depending on the weather, while others are accidental. A very full account is given of the steps taken to determine which of the depressions were real, *i.e.* actually due to absorption lines in the solar spectrum, and which were accidental, and of the method of measuring the twenty-one bolographs selected for final examination and record.

Full tables of the wave-lengths of the lines observed and of their relative intensities are given, and the whole is summed up in the normal map of the solar spectrum, which will be found at p. 200.

The general effect is shown in Plate xx., which gives the infra-red spectrum of a 60° rock-salt prism from the observations of 1898, showing both the bolographs, or energy curves, and the line spectrum. The bolographs are, it must be remembered, continuous curves having peaks and depressions; the method adopted for obtaining photographically from these a diagram of a line spectrum as usually drawn is explained on p. 73 thus:—

"One method of obtaining a linear spectrum consists in blacking in all of the plate below the photographic plate and then photographing this through a combination of a spherical and cylindrical lens, which draws the blacked-in portion out into regions of greater or lesser shade according to the linear depth of the blacked-in portion."

". . . In the original curve the greatest elevations represent regions of the greatest heat, the greatest depressions regions of the greatest cold; and if we fix our attention on these great regions only, they can be adequately rendered into bright and dark bands respectively, but the detail is comparatively ill rendered without a special adjustment, which would in turn give a false presentation of the great masses of light and shade."

This treatment, illustrated by figures in the book, consists of blacking out the whole of the under side of the curve and most of the upper side, but leaving as a transparent spot a small area at the vertex of each marked depression, the size and shape of the area depending on

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[1] "Annals of the Astrophysical Observatory of the Smithsonian Institution." Vol. i. By S. P. Langley, Director.

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the form of the curve. When this plate is photographed, a series of dark lines, the intensity of which depends on the size and shape of the corresponding transparent areas, is produced. By superposing this photograph on the former one which gave the general distribution of light and shadow, a representation of the linear spectrum of the bolograph is obtained. Clearly, considerable skill and judgment are required in such a process, and the linear spectra are only introduced to show the general effect and to enable the reader to compare the infra-red with the visible spectrum; the measurements of the position of the lines are all made on the selected bolographs themselves.

Chapter vii. contains an interesting account of the variations of absorption in the infra-red spectrum, which is shown to be the seat of great terrestrial atmospheric absorption, the relative intensities of energy changing greatly at different periods of the year in some portions of the spectrum, while in others they remain fairly constant in amount.

But little space is left to refer to Part ii., subsidiary researches, which to a student of theoretical optics may prove even more interesting than the main research. The first of these deals with the dispersion of rock salt and fluorite. It is sufficient, perhaps, to say that the dispersion curve for rock salt is drawn from wave-length 0·5 μ to 6·5 μ, and the results compared with a formula —Ketteler's formula,

$$n^2 = a^2 + \frac{M_2}{\lambda^2 - \lambda_2^2} - \frac{M_1}{\lambda_1^2 - \lambda^2},$$

where

$$a^2 = 5{\cdot}174714$$
$$M_2 = 0{\cdot}0183744$$
$$\lambda_2^2 = 0{\cdot}015841$$
$$M_1 = 8949{\cdot}520$$
$$\lambda_1^2 = 3145{\cdot}695.$$

This formula agrees admirably over the whole range.

Another appendix gives a full account of the construction of the galvanometer used for the research. In this instrument, various sizes of wire were used in the different sections of the coil; its resistance was 28 ohms, and the external radii of the three sections of which each coil is composed are respectively ·383, ·741 and 1·632 cm.

Two magnet systems were tried, the one being 2·4 mgs. in weight, the other 6·5 mgs. With the former, which proved too light for the work, a deflection of one millimetre at a distance of one metre was given by a current of 5×10^{-12} ampere; with the latter the current required was 23×10^{-12} ampere.

Enough, perhaps, has been written to indicate the interest and importance of the work. Prof. Langley is to be congratulated in having brought it to so successful a conclusion.

R. T. G.

SOUTH AMERICA.[1]

IN the volume under notice, Mr. A. H. Keane gives a much needed compendium of the geography of South America. Since its independence from Spain and Portugal, that half-continent has been making great commercial strides, until its trade now equals in value that of British India. The importance of its varied products, its peculiar ethnological history, its wonderful physical features, its modern political advancement, make it a region of constantly increasing interest to the merchant, the man of science, the student and the statesman; while the fact that only about five-sevenths of it have thus far been explored and partially mapped makes it a favourite field for the geographer. Mr. Keane appears to have understood exactly what the world in general required from his able pen, and instead of confining himself to geography pure and simple, as the title of his work indicates, he has taken his subject in its most comprehensive sense. He gives us, in three preliminary chapters, the physical features of the country, its orography, great plains, plateaux, fluvial systems, seaboard, fjords, outlying islands, climate, flora and fauna and a valuable dissertation upon the ethical and later ethnical and historical relations of its much scattered tribes. He holds it to be "beyond reasonable doubt that man had spread in early Pleistocene times from his eastern cradle to the New World, probably by two routes —from Europe by the still persisting land connection with Greenland and Labrador, and, from Asia, by the narrow Bering Strait." He bases this assertion upon the fossil remains of man which are found in North and South America, "representing the two primordial types, which may be called the long-headed Afro-European and the round-headed Asiatic. These, strange to say, are found in far greater abundance in the southern than in the northern division." . . . "The inference seems inevitable that South America was already in Pleistocene times peopled to its utmost limits by two primitive races that still persist in the same region"—a statement which admits of doubt. "The long-heads are believed to have been the first arrivals . . . and later the round-heads," the latter "generally keeping to the Pacific side." The former are supposed to have afterwards migrated from their early settlements in southern Brazil and Argentina over a greater part of eastern South America.

There is no more delightful and vexatious field for anthropological and ethnological research than South America. The physical alterations which it has undergone, even in very recent geological periods, the separation of its eastern from its western portion by immense inland seas, the vast denudation of the orographic system of the Brazilian and the recent uplifting of the Andean section, the formation of its wonderful rivers, all probably largely effected since the occupation of the continent by man, have woven many factors into the problem of racial development there. The few traces which forgotten peoples have left under extraordinary physical changes and climatic influences, and the fragmentary knowledge existing regarding South American tribes, make it appear venturesome to indicate the routes by which their progenitors first penetrated the southern half of the New World. The problem seems to require more study than it has yet received before its solution can be safely approached. But the somewhat extensive remarks of Mr. Keane upon South American ethnology are very valuable—doubly so from the fact that he not only summarises his views in his "General Survey," but elaborates them as he afterwards passes each country in review, thus making his work of great importance to the student of tribal origin and development on the western continent. Mr. Keane justly comments on the purity of race in the United States in comparison with Latin America, "where all the ethnical elements have, from the first, tended to be merged in a fresh division of mankind, which may eventually acquire a uniform character, but must long continue to betray its diverse origins in the heterogeneous nature of its physical and mental qualities." And yet it is not entirely improbable that in several of the Spanish American States, notably Mexico and Bolivia, the mentally and physically strong native race are reasserting themselves, and absorbing, thinning-down and gradually dissipating the blood of their conquerors.

The description of each State includes its boundaries, so far as they are claimed or defined, its physical features, hydrography, climate, flora, fauna, inhabitants, wild tribes, topography, chief towns, period of discovery, conquest, settlement, colonial rule, religion, education, natural resources, mineral and agricultural productions and a

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[1] "Stanford's Compendium of Geography and Travel (new issue) Central and South America." Vol. i. By A. H. Keane. Edited by Sir Clements Markham, K.C.B., F.R.S. Pp. xxii + 611. (London: E. Stanford.) Price 15*s*.

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